DECONSTRUCTING THE COMPLEXITY OF SMART URBAN PROCESSES BASED ON THEIR DEGREE OF 'EMERGENCY': TWO CASE STUDIES FROM THE FIELDS OF HEALTH AND URBANISM

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ABSTRACT

The aim of this paper is to introduce the concept of 'emergency' and 'non-emergency' processes in smart cities. A smart city efficiently manages the whole complex network of urban operations that address the various manifestations of urban life and unravel within different space and time-frames. In this context, this paper proposes that managing the abundance and complexity of cities operations premises their deconstruction and organisation. This can be achieved through the creation of a prioritized hierarchy of urban processes based on various criteria, including their degree of 'emergency'.

The concept of degree of 'emergency' is presented through two indicative case studies. The first study presents an 'emergency' process drawn from the field of health, and relates to the real-time management of emergency situations regarding pediatric patients with epilepsy through a 24/7 web and phone network. The aim of this network is to connect patients to data and specialized health professionals in order to offer them personalised, direct and efficient medical help.

The second study presents a 'non-emergency' process drawn from the field of urban planning and design. This is a long-term pilot plan for the Athenian neighbourhood of Kaisariani. It aims at releasing public space occupied by parked vehicles in densely built urban areas and promoting sustainable mobility. Its goal is the design of a network of urban equipment that supports a new concept in urban commuting, based on the modern development in telematics that allows for a combined and comfortable transportation in the city without using cars.

Keywords: *complexity, smart cities, emergency, sustainable mobility*

1. INTRODUCTION

More than half of the world's population now lives in urban areas, while the ratio of urban population to rural is expected to rapidly grow within the next two decades (Dirks et al. 2010). The result of the congregation of population in cities is the generation of complex and disordered systems where new kinds of problems emerge. These problems demand the response of smart processes that exploit the potential of the existing technology in ensuring livable conditions in urban areas (Chourabi et al. 2012).

The inherent complexity of cities is intertwined as a fabric of overlapping networks of relations between individuals, places and information. In order to understand the above nexus and manage its complexity it is essential to deconstruct it. This deconstruction can be achieved based on multiple criteria, including the sector of urban life that each operation addresses, the space and time frame within which it unravels, its top-down or bottom-up mode of development and others. This paper introduces the concept of the degree of 'emergency' of urban processes as a criterion of organizing urban processes and their corresponding systems of management.

'Emergency' can be defined as an urgent and unexpected occurrence that requires immediate action. Emergency operations differ from the 'non-emergency' ones regarding their alertness and their limited, often real-time, responsiveness. They might address issues of traffic congestion or accidents (Djahel et al. 2013), or emergency warning systems responding to natural disasters (Groupe Speciale Mobile Association 2013), where insufficient management of emergency services might lead to a few minutes delay risking human lives as well as financial losses.

On the other hand, 'non-emergency' smart processes unravel within longer time frames that permit their gradual integration in existing urban systems. The application of such processes permits the study of their implementation and impact on society and, consequently, their re-adaptation, but also the reciprocal evolution of the proposed and existing systems.

In this context this paper presents two smart processes that are drawn from the Greek reality and cover two different fields of urban life. The first, is an 'emergency' smart process drawn from the field of healthcare that aims to the real-time management of pediatric epilepsy through 24/7 web and phone network; the second, is a 'non-emergency' process drawn from the field of urban planning and design, proposing a long term plan towards the promotion of sustainable mobility in smart cities, while addressing the lack of public space in densely built urban areas that suffer from high rates of private auto ownership.

2. AN 'EMERGENCY' PROCESS FROM THE FIELD OF HEALTH

2.1 BACKGROUND

Epilepsy is a common disorder affecting 1% of children population. The unpredictable nature of the disease, the significant variability of epileptic episodes in type and severity, and the frequent long-term drug treatment adjustments require continuous personalized health counseling. In addition, managing emergency situations and follow-up is often difficult because of the insufficient number, especially in rural areas, of specialized health professionals and the absence of electronic medical filing. Consequently, the need of setting up an efficient real-time communication network that will serve epileptic families' needs is fundamental.

The first 24-hour children epilepsy hotline and official website in Greece will be implemented within the framework of Epilepsy Clinic at the 3rd Pediatric Clinic of Attiko University Hospital in Athens. The project is supported by the Angelopoulos scholarship program in cooperation with Clinton Global Initiative University.

The objective is the immediate and efficient management of emergency and urgent individualized situations regarding pediatric patients with epilepsy through their direct access to specialized medical health. This will be achieved by the creation of a 24-hour hotline supported by the team of the Pediatric Neurology department of Attiko University Hospital. The service's efficiency will be increased by patients' close follow-up and detailed data registration.

Part of the project concerns the management of non-emergency situations which will be covered through a website. The website will provide official information concerning children's epilepsy, and the ability to pose questions about the disease via e-mail.

The project is part of a more complex network that would eventually connect patients and their caregivers to data and specialized health professionals in a smarter way using interactive technology.

2.2 24-HOUR CHILDREN EPILEPSY HOTLINE AND WEBSITE

The 24-hour children epilepsy hotline will be supported by a 4-member staff: a pediatric neurologist, a specialized nurse practitioner, a pediatrician and a graduate medical student. The latter three will be answering calls in 8-hour shifts, and will directly contact the pediatric neurologist when necessary. Each will possess a smartphone and a tablet. The smartphone will be used for receiving calls, teleconferencing with team members, and identifying the hospital on duty that is nearest to the patient. The tablet will be used for direct access to the patients' electronic history files.

The objective of the hotline will be the immediate management of emergency and urgent situations of children with epilepsy, mainly at Attiko Hospital. However, the hotline will be available to patients all over Greece. It will offer medical help in emergency and in less urgent situations. Emergency cases include epileptic crisis and allergic reaction to antiepileptic drugs, in which first aid instructions will be given via phone. It will also be decided whether hospitalization is necessary, and patients will be referred to the nearest health center on duty. Urgent situations might concern conditions such as incorrect antiepileptic drug administration, adverse drug reactions and drug interactions, crisis triggering factors, and conditions confused with epileptic episodes. The team in charge will also update the treating physician on the instructions given, and recall all patients to monitor their progress. All data will be stored in electronic filing, and used for patients' follow-up. Emerging statistics will be used as a service efficiency marker.

The children's epilepsy website will provide information to the public about pediatric epilepsy and the Epilepsy Clinic's activities in Attiko Hospital. Any non-emergency question concerning epilepsy will be posed and answered via e-mail. The website will also include a platform that will localize and offer personal address data on epilepsy centers and physio/ work-therapists in a region.

2.3 SMART CITY REQUIREMENTS

2.3.1 EPILEPSY SMART ALARM

Emergency situations concerning pediatric patients with epilepsy require direct personalized access to specialized health professionals. By using interactive technology a smart network that is more efficient than a 24/7 hotline can be created that will connect patients and their caregivers to health professionals and health centers that specialize in pediatric neurology in Greece and abroad. This smart network might be developed by the combination of:

(a) SMART CALL

Patients and their caregivers are now connected with specialized health professionals via mobile technology. In the future, emergency cases can be separated from urgent ones through a voice recognition program as soon as the call is answered. The caller will choose a priority line for emergency conditions and, in the meantime, the program will confirm his selection by recognizing a stressed tone of voice. Immediate contact with a health professional specialized in epilepsy leads to proper treatment of the epileptic crisis, to the reassurance of the caregiver and the avoidance of unnecessary hospitalization, since most seizures are ceased by administrating the appropriate antiepileptic drug on the 3^{rd}-5^{th} minute of the episode. If the health professional judges that the child needs to be transported to a hospital, an automatic tracking system will be activated and an emergency signal will be received by the ambulance that is nearest to the patient.

(b) SMART DEVICES

Apart from call-activated emergency intervention, other smart ways can be used to alarm an ambulance and the health unit that is nearest to the patient. High technology devices attached to the patient may track abnormal body activity, such as limb movements, respiration and heart rate, ECG and EEG, and detect epileptic seizures. Smart-watch (Smart Monitor 2013) is already being used by parents for tonic-clonic seizure detection, a type of epileptic crisis which might be life-threatening when the child is left unattended. The device is also used for studies on epilepsy monitoring by health professionals. Smart-watch uses Bluetooth signals to activate an alarm in patients' smart phone within seconds, and caregivers are informed within thirty seconds about the patient's location, may reach him and call for help if necessary. Other epilepsy smart devices such as smart-belt (Leng et al. 2013) and smart-clothing (Bioserenity 2014) are being developed and used in research, providing a new dimension to epilepsy monitoring. An example of smart epilepsy ambulatory monitoring, which is being studied and implemented in Greece, is the ARMOR project (2011). In the near future, these devices may be widely used for sending real-time direct alarm to health centers' emergency departments so that immediate home treatment will be provided.

(c) ELECTRONIC DATABASE

In addition to direct access to the patient, direct access to his medical records is fundamental for his finest health care. By creating an electronic filing database, patients' history and medical tests will be automatically accessed by pediatric neurologists in specialized health centers in Greece and abroad. In this way, patients will receive optimal treatment regardless of their location, and doctors who are not specialized in pediatric epilepsy will be easily consulted by experts through real-time file sharing. Smart devices facilitate this effort through automatic electronic storage of patient's monitoring data.

(d) TELEMEDICINE

Telemedicine and video-communication programs may contribute to real-time data sharing. Consequently, epileptic patients living in rural areas will be appropriately treated, while those presenting unclear clinical manifestations will be easily diagnosed and follow the appropriate care plan for their condition. Thus, there will be a significant reduction in emergency, and often unnecessary, patients' transportation to a pediatric epilepsy clinic which is available only in a limited number of Greek cities. Moreover, multiple drug resistant epilepsy cases often require patient's multiple visits to other medical centers that specialize in epilepsy in Greece and other countries. Electronic history filing and telemedicine will facilitate experts' cooperation in setting the best treatment plan.

2.3.2 EPILEPSY SMART SOCIETY

Emergency alert leads to the proper management of an epileptic episode. However, an epileptic crisis is not always noticeable as it may occur with a great variety of non-convulsive clinical manifestations. Caregiver's unawareness of epilepsy's diversity results in delayed diagnosis and late onset treatment. When society is properly informed about the disease, it may recognize its symptoms, be alarmed and act in the smartest way. This may occur via education through the web, and through interactive training seminars for patients, families, teachers and friends, and public in general.

Epilepsy smart schools are fundamental in forming an epilepsy smart society. A smart school is 'one that understands epilepsy and puts in place inclusive practices to support a student with epilepsy to achieve their academic potential and develop positive social relationships' (Epilepsy Foundation 2013). The Epilepsy Clinic in Attiko University Hospital is contributing to smart school development through training seminars to school teachers. Through teachers' and health professionals' cooperation, further education of healthy students and parents may fully form an epilepsy smart school's society.

3. A 'NON EMERGENCY' PROCESS FROM THE FIELD OF URBANISM

3.1 BACKGROUND

The study proposes a long term plan that aims at the promotion of sustainable mobility in smart cities, while addressing the lack of public space in densely built urban areas that suffer from high rates of private auto ownership; in this case Kaisariani, Athens. This is achieved, first, through the release of public space occupied by private cars, allowing space for the expansion of public transport networks, cycling and walking. And, second, through the design of flexible infrastructure that supports a new concept in urban commuting, based on telematics that allows for multimodal green and comfortable transportation in a smart city at substantially depressed levels of auto ownership.

3.2 THE CASE STUDY OF A SMART CITY: KAISARIANI

The study addresses the opportunities for a smart city to take advantage of tools from intelligent transport, in order to promote green infrastructure and achieve sustainable mobility. At the same time, the new approach will address a key urban barrier in a typical densely populated Greek city, i.e., the high rate of auto ownership. As a result of this feature, driven and parked cars occupy public space depriving it, impeding the movement of pedestrians and bikers and the extension of ground public transportation networks, and degrading the quality of life.

Kaisariani is an indicative example of a semi-central Athens neighbourhood that features a high density in terms of building stock and public space occupied by private cars. Despite being situated only around 2 kilometers from the center of Athens, heavy traffic and the insufficient network of public transport makes commuting and other trips to the city center problematic.

However, despite its density there still remain few private lots and lots with one and two story buildings that were built in 1925-1935, most of which are abandoned wrecks. These remaining unused private spaces offer the possibility of redistribution and beneficial use of the remaining free space within the reformulated green plan of a smart city. This space could be used, for instance, to support the intelligent network needed by dynamic carpooling, electric vehicles (EVs), electric bikes (e-bikes), and automated vehicles (AVs) sharing and storing.

Finally, the proposed expansion of the tram in the frame of the Syntagma-Kaisariani route (Fig. 1) according to the 2004 study of the National Technical University of Athens, ‘Complete tram network within the urban system of Athens – Extensions until 2008’ (NTUA 2004), provides the scenario for the development of a multimodal transportation network in the area – tram, intelligent bike and pedestrian routes. At the same time, the tram expansion towards the main central road of Kaisariani, National Resistance Street, requires an immediate solution of the problem created by parked cars since the location of the tram in the central lane requires banning 560 parking spaces (NTUA 2004). According to the study, the banned spaces belonging to the residents should be replaced by new ones in designated areas where new spaces will be created.

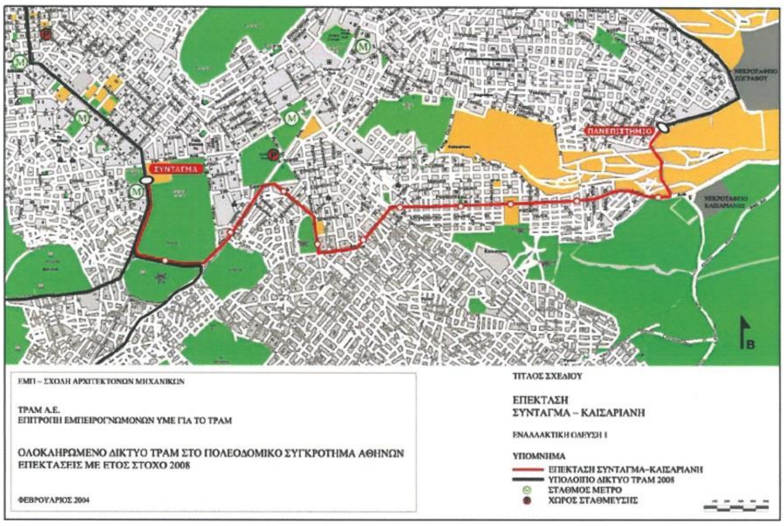

Figure 1 Proposal for expansion of the tram from Syntagma to Kaisariani (NTUA 2004)

3.3 THE STAGES OF THE PROPOSED PLAN

The project is unfolding in four stages. The first phase includes standardising and re-designing the profile of the streets of the area by giving priority primarily to pedestrians and secondarily to traffic; by doing so, a large number of off-street parking spots are banned. However, the banned parking spots are recovered in vertical, light and easily removable and transferable garage buildings which are to be constructed in available lots or lots that can be expropriated.

The managing of these garage buildings will facilitate car sharing, dynamic carpooling, EVs, e-bikes, and AVs policies.

In the second phase, the newly freed public space will be used for the design and implementation of a network of public transport - the tram in the Kaisariani case -, adoption of a telematics-supported network of bicycle units, and one incorporating public W.C. and kiosks which function either as supplementary to the previously mentioned network or autonomously for the flexible upgrading of city areas with dense infrastructure that malfunction because of lack of facilities and connectivity to central areas of the neighbourhood (e.g. parks or stadiums at the periphery of the area).

Continuing with the third phase and having in mind that the new transport network will satisfy many types of trip needs, the acquisition of a new car will be unnecessary in 5-10 years from now. Thus, a gradually increasing percentage of parking spaces available in the vertical garage structures (10%, 20% etc.) will be transformed into space for public transport vehicles. With the help of telematics, communication and information are provided electronically, while the use of a single card facilitates the operation of public transport, car-sharing, dynamic carpooling, bike-sharing and automated vehicles functioning in a supplementary and integrated way.

In the long run, when part of the vertical garage construction is not needed, it can be taken apart, used in other problematic areas or be recycled; thus, the land will be freed.

3.4 THE ANALYTICAL SCALES

The project is developed in two scales of analysis: macro and micro-analysis. Macro-analysis refers to the study of the urban planning of the area and suggests ways for handling the traffic, standardizing and enhancing the existing street profiles, and adopting a network of garage constructions, dynamic carpooling meeting spots, rental bicycle/e-bicycle units, rental EVs, AVs, public W.C. and kiosks. The second stage of micro-design includes the architectural design of the above mentioned construction, and its sustainability and flexibility regarding its location.

3.4.1 MACRO-ANALYSIS

The analysis of the area starts with the distribution of the space of the study area in private and public space, built and non-built space, ‘dead’ private space with real estate that can be expropriated, ‘active’ public space for pedestrians and bicycles, and ‘dead’ public space occupied by parked cars. The redistribution of space is suggested at the exchange of ‘dead’ space, both public and private, and the release of ‘active’ public space, that is the removal of parked vehicles to vacant lots or lots that can be expropriated, and the use of the freed space for the benefit of pedestrians and bicycles.

The intervention study includes the following stages:

1. It starts with standardization of the streets of Kaisariani depending on their main design features and re-design. The goal is to give priority to pedestrians and bicycles, and secondarily to traffic. This results in banning a considerable number of parking spots.
2. Next, the area is divided on the basis of the intensity of intervention, and the scope and service of the station unit in various possible areas. The location of garages is chosen in order to relocate the banned parking spaces.
3. Afterwards, the expansion of tram is considered according to the submitted study (NTUA 2004) and the traffic regulations that this study specifies.

4. The project continues with the study of existing local centers, the ones that are expected to develop with the tram expansion, and the existing areas that do not lack important premises but malfunction owing to inadequate access.
5. The location of the smaller bicycle/e-bicycle rental units, dynamic-carpooling meeting kiosks and W.C. needs is specified, and a network of transverse streets connected with the National Resistance Street is proposed with priority given to pedestrians and bicycles.
6. The location of the larger EV and AV rental units is specified in accordance with the location of bicycle units and kiosks. In this way, all frequent centers of the area and zones that are expected to get developed after the expansion of tram become part of the existing network and function in unison.
7. According to the above, the suggested network of multimodal green transportation for the smart city emerges (Fig. 2), with tram stops, garage units, auto rental units, support kiosks, W.C. – which intersect in order to operate in a single united way – and the necessary transverse connections.

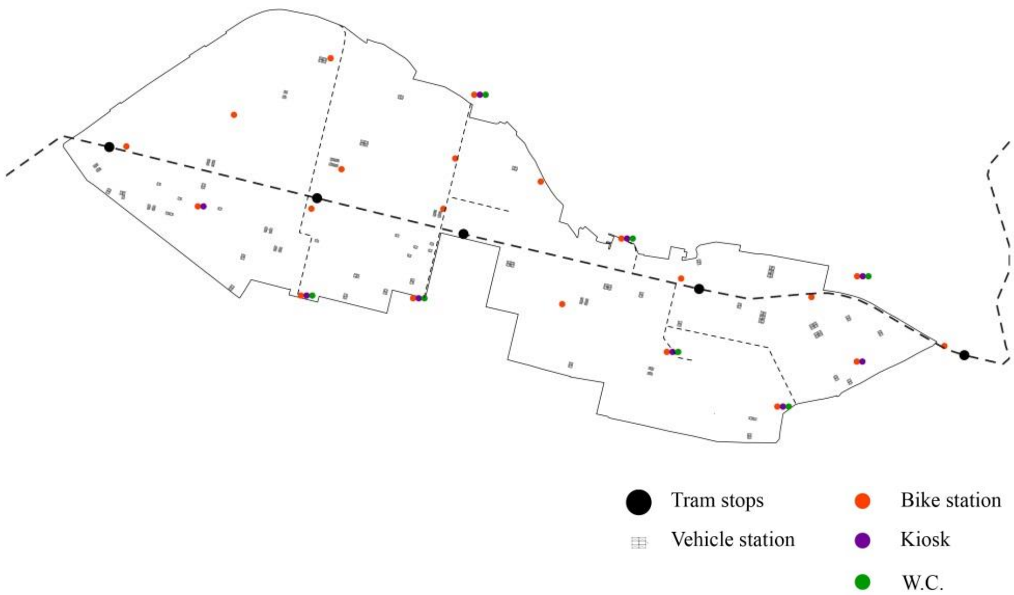

Fig. 2 Suggested network of multimodal green transportation

3.4.2 MICRO-ANALYSIS

Proceeding to the design for the units (garages, vehicle rental units, W.C.s and kiosks) that are integrated in the above smart network, garage structures are designed based on three modules (A1, A2, B) and their variations, depending on the terrain and geometrical characteristics of the lots. The basic modules include one garage of each type, A1, A2 and B, the three more common, 12, 26 and 52 parking spaces, respectively, in three different location cases. The larger garages in terms of vehicle capacity also include areas for mini-service for the vehicle, repairs, emissions checks and battery change or recharging in case of electric cars as well as communications networks to support automated vehicles (Fig. 3).

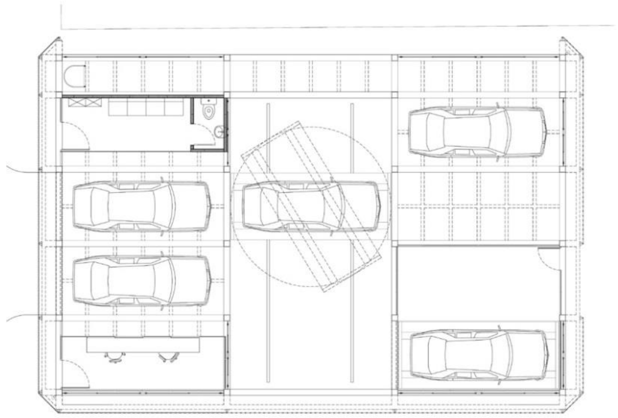

Figure 3 Ground floor plan of indicative garage types (A2 and B), with a capacity of 12 and 52 cars respectively

The garages are light weight metal constructions that can be easily put together, removed from the lot without leaving traces, and reused in other areas or get recycled (Fig. 4). The vehicles are transferred to different floors in a lift located in the center of the building. Only the ground floor is accessible to the public, where there is a room for the handling of machinery, a reception and a meeting room for the users – including W.C., lounge and pay machines – supporting the use of this lobby as a meeting point for co-travellers through online car-pooling platforms or car-sharing users.

The planted facades of the garages are mainly watered through the collection of rain water at the roof of the building, and achieve soundproofing – especially towards the back court -, absorption of dust and harmful gas emissions, protection of the metallic construction from extreme weather conditions, and limitation of heat variation in the building.

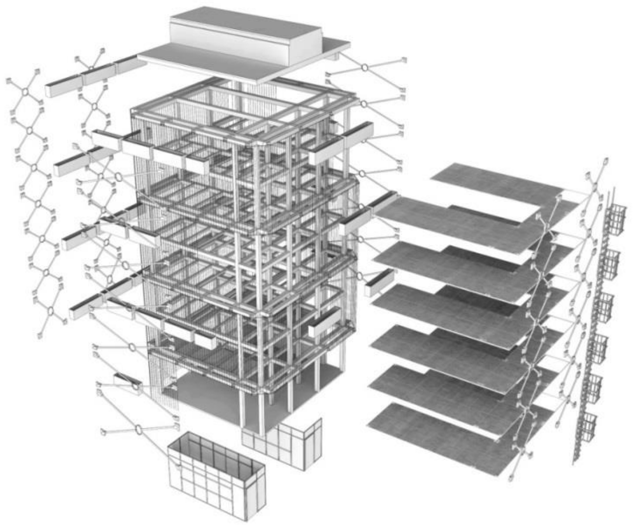

Figure 4 Structural analysis of typical garage structure with capacity of 12 cars

Bicycle rental, W.C. and kiosk units are also light and easily removable and transferable metallic structures. In order to be moved, the units close and the opening parts work as shelters and service corridors (Figs. 5, 6). They are also equipped with adjustable legs in order to adjust to pavements of different height, while service metallic grates unite the traffic. Finally, they can be placed in all possible combinations while they are put together or taken apart without leaving traces occupying the place of parked cars - 2,40 meters wide.

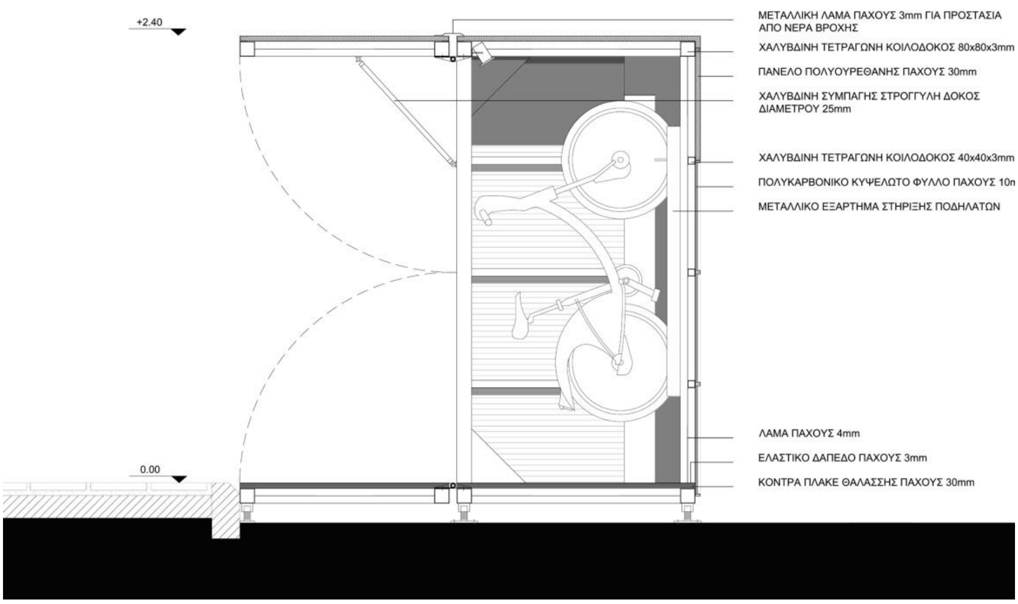

Figure 5 Longitudinal section of bicycle rental unit

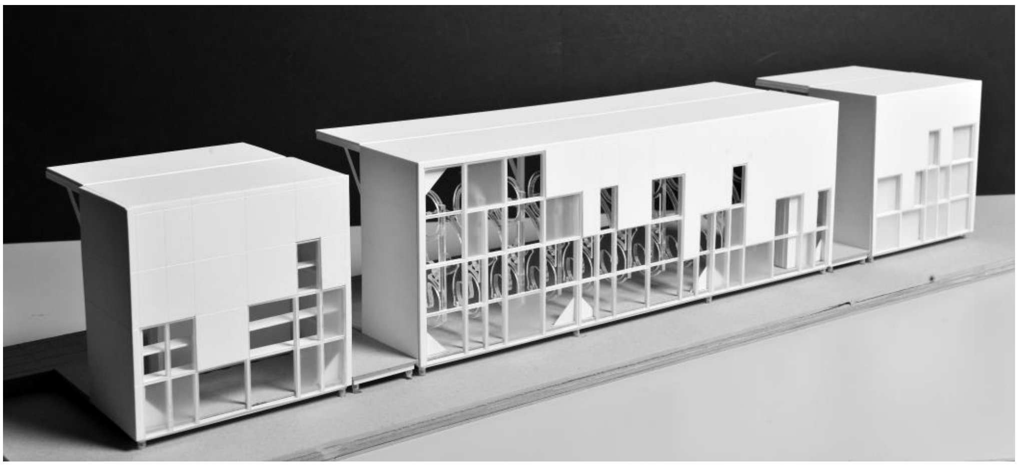

Figure 6 Easily transferable units that can be packed in a single container

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